Natural Resources Canada
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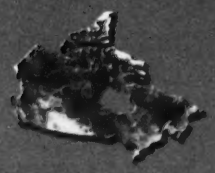
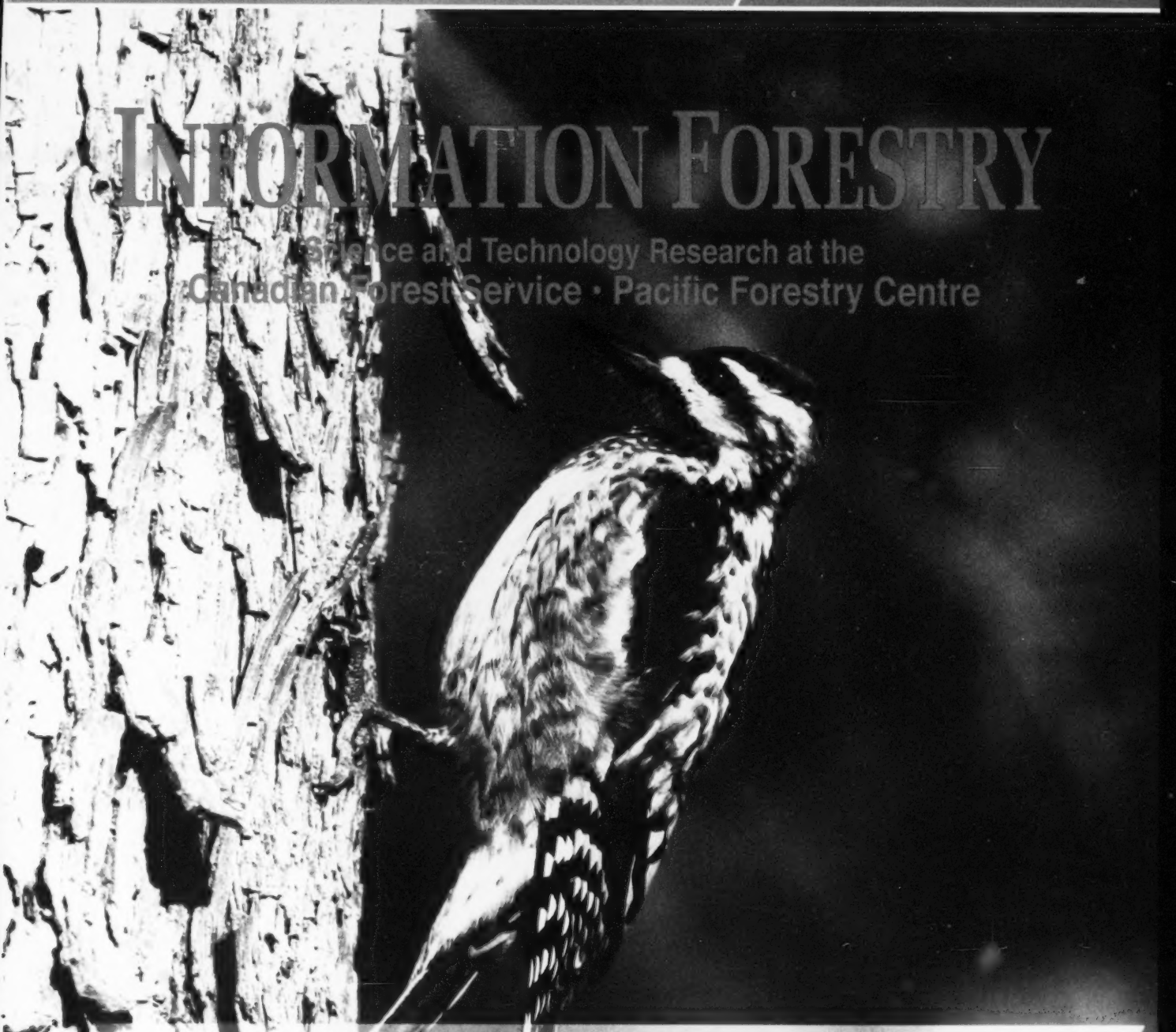


INFORMATION FORESTRY

Science and Technology Research at the Canadian Forest Service • Pacific Forestry Centre



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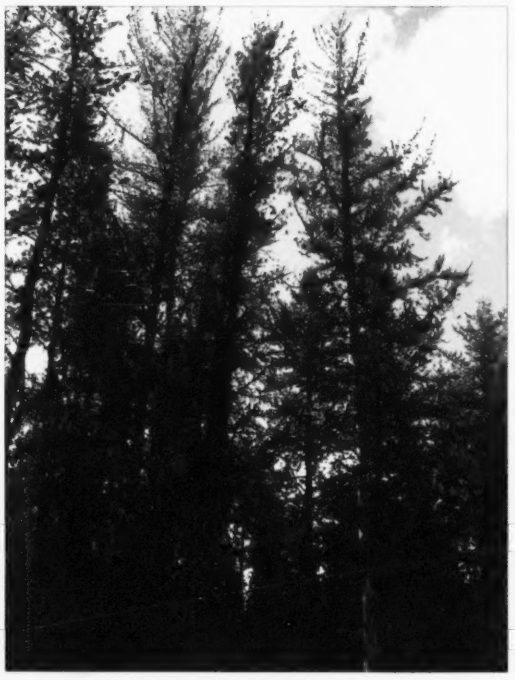
Canada

Mountain pine beetle's eastern spread opens new frontiers of research and modelling

East of Lesser Slave Lake in the "hybrid zone" of central Alberta, Barry Cooke scrutinizes an MPB-attacked tree that was also heavily attacked by woodpeckers. Between these two mortality agents, very little pine survived the winter of 2009–10 in this region.
Image: Jim Weber



MPB-attacked stand east of Lesser Slave Lake that, according to genetic testing, is jack pine. This attack cluster was initiated in the summer of 2008 and is the first definitive proof that MPB have undergone a host range expansion.
Image: Jim Weber

As the mountain pine beetle and associated bluestain fungi tag-team their way across the boreal forest of Alberta, questions spring up about the beetle's ability to adapt to new territory, and what it could mean for local communities and the environment. Natural Resources Canada researchers in both British Columbia and Alberta are finding new ways to mitigate the beetle's devastating effects and to model decisions amid uncertain futures.

Lodgepole pine, the beetle's main host, dominates British Columbia and Alberta both in abundance and value on the pine market. Alberta's jack pine is a suitable host, too, raising concerns that it could act as a conduit for the beetle to move across the nation's boreal forests. East of the Rockies, a hybrid of jack and lodgepole occurs in north-central Alberta. Despite the cold boreal winters and the thinner phloem (the source of food for larvae and adults), beetles are persisting.

"The beetle is well into the hybrid zone," says **Dave Langor**, an entomologist specializing in biodiversity and pest management at the Northern Forestry Centre (NoFC) (David.Langor@nrcan.gc.ca). "If they showed up in pure jack pine in 2010, it wouldn't surprise me at all."

In fresh environments, what's old is new again to scientists studying the beetle. Its biology in central BC—the density of larvae in trees, for example, and its reproductive, mortality, and spread rates—may differ in Alberta. The density and defensive chemistry of pine trees in boreal hybrid and jack pine forests, characteristics of the local bluestain fungi, and mortality factors all may drive beetle dynamics slightly differently. And no one knows how the beetle will fit in among resident pests like vascular plant dwarf mistletoe.

"Now that the beetle and its associated fungi are established, they undoubtedly will persist in the boreal," says Langor. "With much genetic variation and short generation times, they will adapt quickly to the local environment."

Despite so many unknowns, local communities must decide how to handle the beetle before it whirls through. Much is at stake: forestry is Alberta's third largest industry. At $9 billion a year in revenue, some 38 000 jobs and 50 communities depend on it.

Barry Cooke (Barry.Cooke@nrcan.gc.ca) and colleagues at NoFC are looking at the consequences of uncertainty in making such decisions.

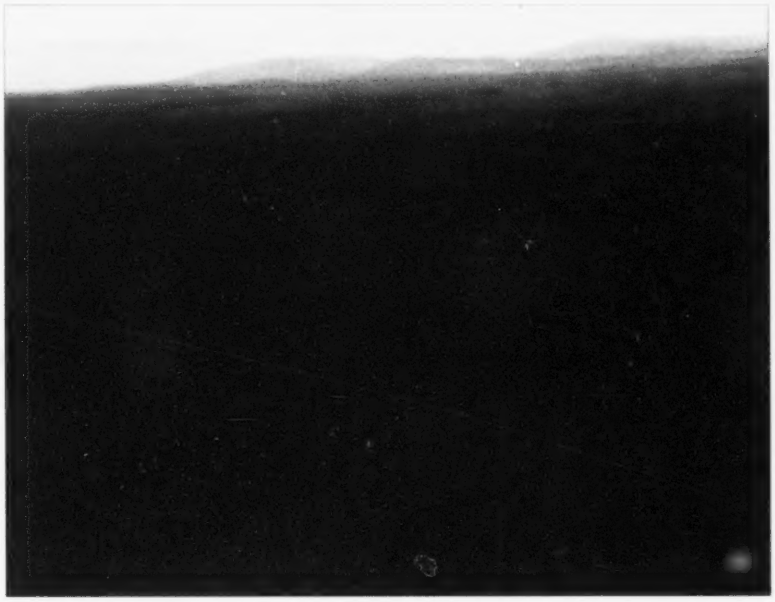
continued on page 3...

Survey reveals community of tiny organisms living on spruce beetles

A survey of micro-organisms associated with the spruce beetle has shed light on the tiny community that lives on the insect and may govern its success. The study paves the way for research into managing the beetle and its micro-ecology, which may help minimize attacks to spruce stands.

The beetle *(Dendroctonus rufipennis),* native to North America, poses a threat to mature spruce stands throughout the province. An infestation starts innocently, with beetles normally breeding in weak or downed spruce trees and logging residue. Large populations that build up in such host material are one of the main causes of outbreaks in apparently healthy trees. The other main cause of outbreaks is reduced tree vigour due to senility, drought or other factors, such as rising temperatures. Warm temperatures can also shorten the normal two-year life cycle to a single year and increase beetle survival, resulting in rapid population growth.

Its insidiousness is what makes the beetle so important to study. "One year, you don't see any infestation in apparently healthy trees," explains Natural Resources Canada Emeritus Research Scientist **Les Safranyik** (les.safranyik@nrcan.gc.ca), a bark beetle ecologist at the Pacific Forestry Centre. "The next, it can appear in millions of hectares." The beetle's explosive nature makes understanding its biology crucial to managing spruce populations, both in clearcuts, where it often incubates in the fresh logging residue, and in windfall and weakened trees in forest stands.



A spruce beetle-attacked forest in central BC.
Image: Les McMullen.

Studies conducted in the 1970s started to uncover spruce beetle biology, but mountain pine beetle outbreaks redirected entomologists' research and shelved many spruce beetle projects for decades. "Spruce beetle could be the next big one," says Canadian Forest Service bark beetle ecology Research Scientist **Kathy Bleiker** (katherine.bleiker@nrcan.gc.ca) "it has a wide distribution in Canada and outbreak potential."

...continued on page 4

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Anticipating beetle movement

"We're modelling the ecology and dynamics of surprise," explains Cooke. For example, investors want to know whether to invest in building a newsprint mill in a susceptible area to handle a surge of timber. By extrapolating existing knowledge to new environments, Cooke hopes to offer a range of outcomes to inform concerned community members. "People want to adapt," he says, "but they need to know what to adapt to."

Many details of beetle behaviour in Alberta are unknown, but its spread east is certain. A Pacific Forestry Centre research team has been studying a new method to anticipate pathways of spread and slow the beetles' eastern movement. Team member **Bill Riel** (Bill.Riel@nrcan.gc.ca) explains: "We are attempting to anticipate the most likely pathways of movement for the mountain pine beetle. From this information, we can identify tactical places to fragment mountain pine beetle habitat. Such gaps in critical locations may slow the beetle invasion and provide stakeholders with much-needed time to choose the best possible responses."

No matter the infestation's intensity, northern Alberta's harsh weather in winter 2009–2010 may have offered a reprieve, says Cooke. Considering the wind has blown the beetle from BC halfway across Alberta in one year, that's good news in the race to manage the imminent changes.

Spruce beetle gallery system with immature brood.
Image: Les Safranyik

...continued from page 3

The micro-organism survey was conducted south of Prince George in an area with large contiguous areas of spruce forest types and a history of high winds that cause much windthrow. (Trees at a stand's edge are particularly vulnerable, where the rough winds and damp soil loosen their roots.) The researchers set insect traps on beetle-infested stumps and windfall in two adjacent timber harvesting areas, then examined the fungi, yeasts, bacteria, nematodes, and mites on the beetles they caught.

The team found a bluestain fungus and yeasts on more than three out of every five beetles. The high rates were expected, as both taxa play vital roles in the beetle's survival. Specifically, bluestain fungi help beetles establish in live trees and may provide nutrients for the developing brood. Yeasts help harden and darken the young beetle's shell, which camouflages it against spruce bark and helps it absorb precious heat as it emerges amid cool spring conditions.

Actinomycete bacteria were isolated from only 10% of beetles, a low number, which Bleiker attributes to the challenges in culturing and identifying them. Interactions between bacteria and fungi under the bark may also impact the insects. Bacteria may inhibit the growth of certain fungi that invade beetle galleries and are harmful to developing insects, or bacteria may compete with the bluestain fungal mutualists of the beetle. The researchers found fewer mites and nematodes than expected, which Safranyik says is not surprising considering they examined only the beetles' exteriors.

"Even though we suspected this (micro-community) existed, nobody has looked before," says Safranyik. "This preliminary study advances our knowledge of the complexities of micro-organisms' associations with the spruce beetle. It also opens new directions in examining spruce beetle ecology and, more distantly, future management."

Model navigates uncertainty in post-beetle stand growth

Foresters across British Columbia are grappling with how best to manage the aftermath of the mountain pine beetle infestation. What happens to wildlife if we harvest vast swaths of beetle-killed pine? Or if we leave them be?

"Resource managers need the ability to determine the ecological shelf life of dead pine stands," explains **Dave Harrison** (dave.harrison@nrcan.gc.ca), Chief Implementation Officer of mountain pine beetle research at Natural Resources Canada, Canadian Forest Service.

A new model developed under the federal Mountain Pine Beetle Program helps foresters do so by measuring salvage logging's effects on biodiversity. When fully developed, the MPB Biodiversity Model (MPBio) will apply to landscapes spanning up to 300 000 hectares. Early trials using local bird species as indicators have already shown some surprising results.

University of British Columbia forestry researchers Ann Chan-McLeod, Pierre Vernier, and Arnold Moy designed MPBio to address ecological consequences of projected management strategies. Building on watershed maps, forest inventory data, and wildlife information, the user manipulates such features as pine composition, retention of beetle-killed pine, and landscape connectivity to see how wildlife populations—particularly those that indicate healthy biodiversity—fare up to 60 years after the harvest.

"No one has made a tool to run like this for sustainability indicators," says Chan-McLeod.

Then they applied it. Using data from bird surveys in the Peace Forest District, the team looked at how retaining 10 to 30 percent of stands with little to lots of pine affected eight bird species. They also considered varying rates of forest re-establishment, from an existing understorey to one that takes 30 years to grow.

Three response types emerged, based on birds' habitat preferences. The guild that lives in mature coniferous forests, including kinglets, thrushes, tanagers, and warblers, normally declined amid any salvage logging—sometimes by as much as half, and rose again as new forest grew. They recovered faster in unsalvaged than in salvage-logged stands.

Flycatchers, which live in deciduous thickets near wetlands, had the opposite experience. Their preference for open forests led their numbers to double and even triple 15 to 30 years after harvesting, before dropping to regular levels once the understorey was firmly established. Their populations in unsalvaged stands dipped before rising.

The red-eyed vireo responded unlike the rest. This vireo lives in open, mostly deciduous, woods, which meant that in MPBio's simulations, the more a stand was logged, the more likely the vireo's occurrence. It was rarest in unsalvaged stands.

Remarkably, retention levels themselves had little effect on the bird populations. "That was a little bit disappointing, but maybe not so surprising" considering their small retention range, says Chan-McLeod.

Retention levels aside, stands are enormously complex and their growth depends on dozens of factors, among them the mix of pine, spruce, and fir; the ecozone; and the degree of damage or shock to the remaining trees from salvage logging. And all of it can change.

"This study shows how quickly habitats deteriorate and recover following beetle attack," says Harrison. "With this model, we hope to project how long the impacted landscapes can effectively support a range of habitat values."

Chan-McLeod says the next steps are to validate some of the assumptions empirically and to ensure strategies are plausible to forest managers. MPBio uses ArcGIS 9.2 and Python scripting language. Sample output, including maps of habitat types and species distributions, can be viewed at the scenario viewer at http://biod.forestry.ubc.ca/mpb/

Sources

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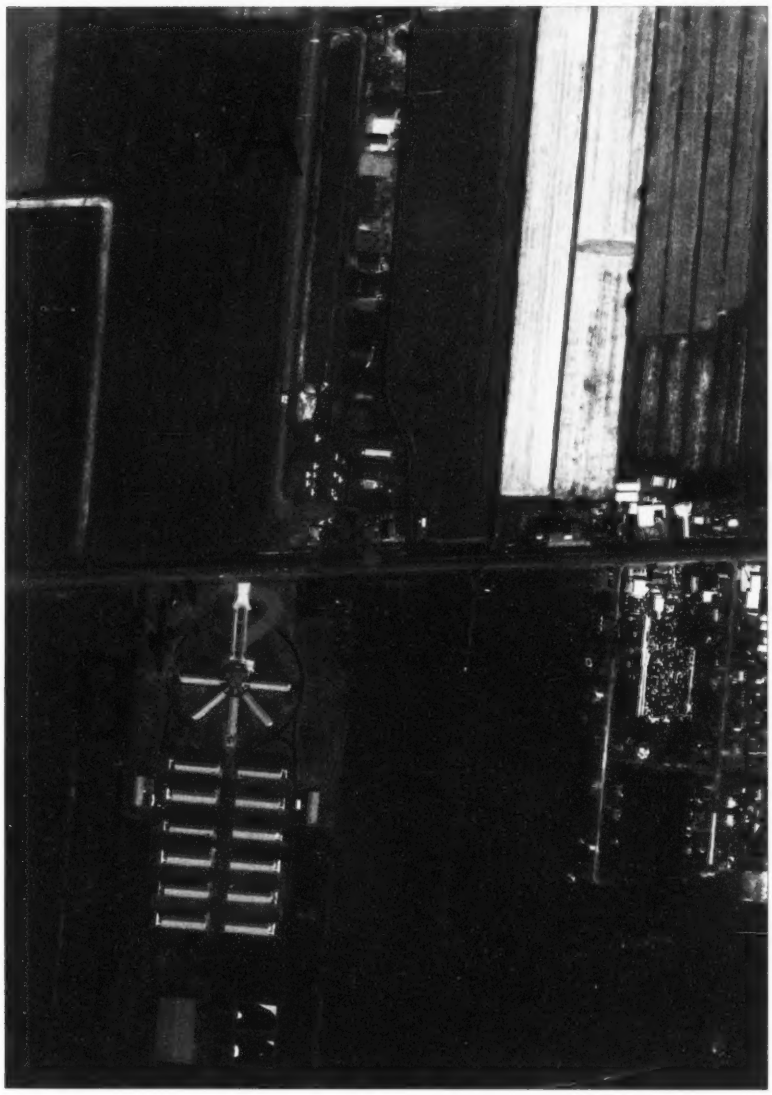
2. MPB Working Paper 2009-23: Decision support tool for managing biodiversity and ecosystem resilience in mountain pine beetle-susceptible landscapes. Chan-McLeod, A.C.; Vernier, P.

Both Available from the CFS online bookstore: http://bookstore.cfs.nrcan.gc.ca/

On the cover:

Yellow-bellied Sapsucker.
Image: Johnny N. Dell, Bugwood.org

Small deforestation team meets big information demands: Ma



Mysterious events encountered during deforestation mapping in Quebec. Can you identify the land use of A and B? (answer on page 11)
Image: Google 2010

The efforts of the deforestation team at the Pacific Forestry Centre (PFC) are helping governments and organizations across Canada achieve their carbon goals. What's more, their newly released online program harnesses web 2.0 momentum to let community members contribute valuable information to PFC's deforestation mapping program.

Under carbon emission guidelines for the Intergovernmental Panel on Climate Change (IPCC) laid out by the Kyoto Protocol, countries must report how much of their forests has been converted from carbon-sequestering ecosystems to new uses. While small countries can pinpoint every tree on their land, Canada's massive size requires remote sensing specialists to track the changes.

At PFC, the four team members map human-induced conversions of forested land. Natural changes like landslides are not considered deforestation, explains Deforestation Monitoring Co-ordinator **Andrew Dyk** (andrew.dyk@nrcan.gc.ca). Neither are clearcuts, as forest will grow back on the land. By combining sampled data from LandSat, Bing, and Google Earth imagery with provincial inventory records and expert judgement, the team has tracked changes over three periods: 1975–1990, 1990–2000, and 2000–2008.

"Every point has a story," says Dyk, and clues in the images help reveal each one. Apart from a patch's size, shape, and colour, the presence of powerlines, pipelines, roads (and whether they lead to clearcuts or to wellpads), or buildings are all pieces in the puzzle.

Each polygon is analyzed by at least three people: a geomatics technician maps the land-use change, a deforestation specialist verifies its accuracy, and every single event is checked by Remote Sensing Research Scientist **Don Leckie** (don.leckie@nrcan.gc.ca).

"We need such careful analysis because, being a sample, each event gets scaled up," explains Leckie. "These estimates must meet international standards and scrutiny. Policy decisions are made based on our results, which means we need consistent checking across the country."

Team members note a patch's new purpose too—specifying, for example, whether a forest area was cleared for industry, agriculture, or municipal expansion—which helps other agencies chart land use. Hotspots have risen and subsided over the years. "The hydroelectricity dams in northern Quebec flooded hundreds of thousands of hectares of forest in the 1970s," says Dyk. Lately, Alberta's oil and gas producing areas are the hotbed of change.

Many CFS partners and clients rely on the data for their own projects: PFC's Carbon Accounting Team analyzes it for Environment Canada's reports to the IPCC, Agriculture Canada applies it to their carbon modelling, and it's crucial to the BC Ministry of Forests and Range in accounting for the province's *Zero Net Deforestation Act*.

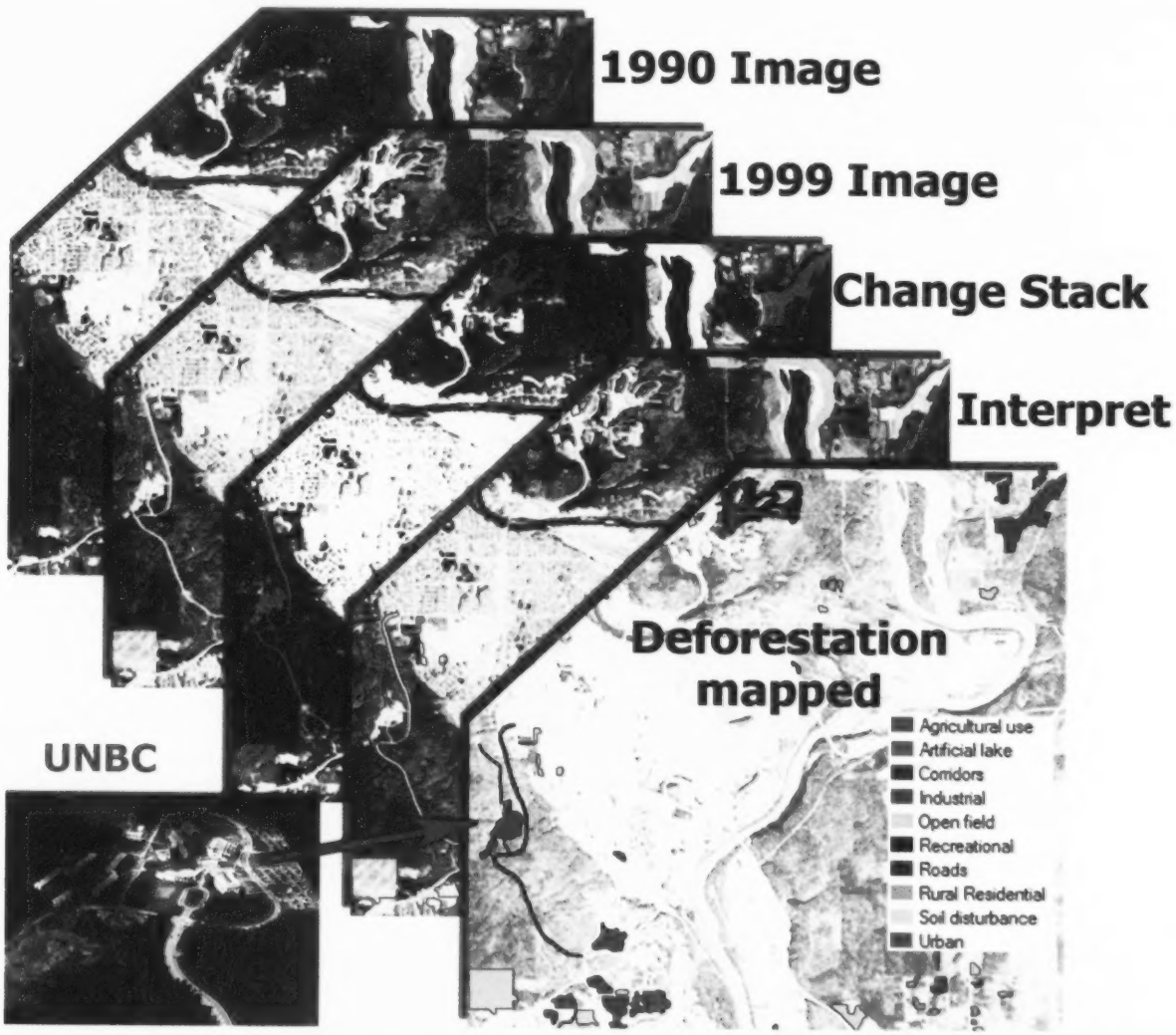
The team often encounters confounding factors: in one image, an area apparently cleared

apping Canada's forest cover loss

for residences has sprouted vegetation. In another, a large building surrounded by pavement offers no indication of its purpose. When a patch or structure stumps the whole team, they ask colleagues in the area or schedule flyovers to determine many points at once.

But a new well of information is about to be tapped. Forest Landscape Analyst **David Hill** (davidallen.hill@nrcan.gc.ca) is developing a program that will let public users anonymously contribute their knowledge of land-use changes in an area. At the Public Input for Deforestation Monitoring site, a user can select a site, choose from categories of new land use, and specify whether their knowledge is local or based on images, or simply offer comments.

"We're using citizen science to help make our work more transparent," explains Hill, "though it's still up to the interpreter to make the final analysis." To check out the program, go to http://nfis.org/, choose your desired language preference, and select "Public Input Deforestation" under Quick Links.

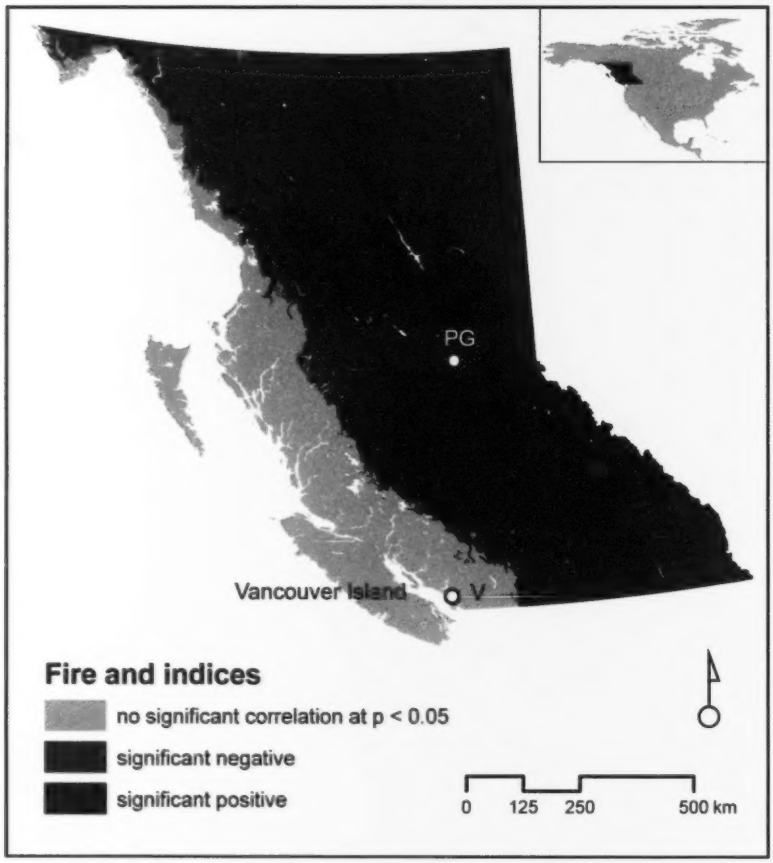


An example of the deforestation mapping steps showing University of Northern British Columbia (UNBC) near Prince George, BC.
Image: Deforestation Monitoring Group, CFS, NRCan

Understanding the relationship between wildfire, climate oscillations, and surface weather in BC

Source
Relationship between fire, climate oscillations, and drought in British Columbia, Canada, 1920–2000. 2009. Meyn, A.; Taylor, S.W.; Flannigan, M.D.; Thonicke, K.; Cramer, W. Global Change Biology 16(3):977–989.

Management of wildfire would be more efficient if resources could be allocated in advance to areas that will have the most fires. Unfortunately, where fires occur changes from year-to-year, and sometimes day-to-day. One reason for the year-to-year variation in fire activity is the influence of climate oscillations, which significantly affect temperature and precipitation regimes in British Columbia (BC). In order to understand the mechanisms underlying year-to-year variation in fire risk, the Canadian Forest Service collaborated with Andrea Meyn and other researchers at the Potsdam Institute for Climate Impacts Research to examine the relationship between climate oscillations, surface weather, and areas burned in the past.



Correlations between annual area burned and PDO + ENSO indices during 1920–2000 were positive in the montane zones in central and southeast BC (black) and negative in the northern boreal zones (dark grey). There were few significant relationships in coastal zones.

"Characterizing the historical variation in surface weather and area burned is a prerequisite for anticipating potential impacts of regional climate change. Understanding how climate oscillations such as the El Niño affect fire activity is an important piece of the puzzle," says Natural Resources Canada Research Scientist **Steve Taylor.** "The historic relationships may provide something of a window into the future."

The research study analyzed spatially explicit fire and climate databases going back to the 1920s to determine relationships between annual proportion burned (APB), climate oscillations such as the El Niño–Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO), and summer aridity in BC. Although the surface weather data used in this study are the best and most detailed, currently available for all of BC, inferences for some areas of the province are more uncertain because they have few weather stations, particularly at high elevations and in remote areas.

In their study, the researchers looked at the combined effects (additive interaction) of the ENSO and PDO climate indices on surface weather as well as on the year-to-year variation in annual area burned. Their analyses revealed the following:

In all but one biogeoclimatic zone in BC, area burned was, not surprisingly, significantly related to summer drought conditions.

Area burned (in summer) was more strongly related to winter and spring PDO indices, as well as additive winter and spring PDO + ENSO indices than to summer phases of these indices. This is likely because ENSO and PDO have a stronger influence on temperature and precipitation in winter and spring than in summer in BC.

There were strong regional differences: area burned and climate oscillation indices were positively related in montane zones in central and southeastern BC. However, they were negatively related in northern boreal zones; few significant correlations were found in the moister coastal zones with lower APB.

The lag in the relationship between area burned (most of which burns in June, July, and August) and preceding winter and spring climate oscillation indices may allow fire managers to anticipate fire activity in advance.

continued on page 9...

New international publication: "Forests and society: Responding to global drivers of change"

Forests and forest-related matters can no longer be addressed in isolation from the surrounding society and natural environment; instead, these need to be seen as an integral part of interrelated social and natural systems. In 24 chapters, this book discusses the drivers of change affecting forests globally and locally. These include global environmental changes and upcoming related policies (e.g., REDD+) as well as socioeconomic changes, such as market tendencies, technological development, and intersectoral pressures, including those from the energy sector. A number of case studies are presented.

This book is the product of World Forests, Society and Environment (WFSE), a Special Project of the International Union of Forest Research Organisations (IUFRO). WFSE is a global, open, non-profit network of scientists and experts steered by 10 international research organisations and co-ordinated by the Finnish Forest Research Institute (METLA). The network focuses on the forest, society, and environment interface. On the basis of existing scientific knowledge, it looks for innovative solutions to support and advance the formulation and implementation of forest-related policies that promote sustainable development and well-being.

This book was developed co-operatively by a network of 159 world-wide science and policy experts, including three IPCC Nobel Laureates. Twenty-eight Canadians, including seven Canadian Forest Service scientists, participated. This publication will contribute to discussions and further research related to the drivers of forest change, and the challenges that forests, forestry, and forest-dependent people are facing today and in the future. Also, this book will focus attention on the possible new opportunities the changes may bring about.

Alex Woods, BC Ministry of Forests and Range Scientist, told Series author and editor **René Alfaro** (PFC), "Congratulations on this publication. It is a very valuable resource. I am finding lots of material useful for a presentation I am preparing for an international audience. This book highlights the crucial role forests play in the epic challenge of our age, adapting to global climate change."

Source

IUFRO World Series, Volume 25. Print copies or a DVD version can be ordered for free or downloaded from the IUFRO website via the Canadian Forest Service online bookstore.

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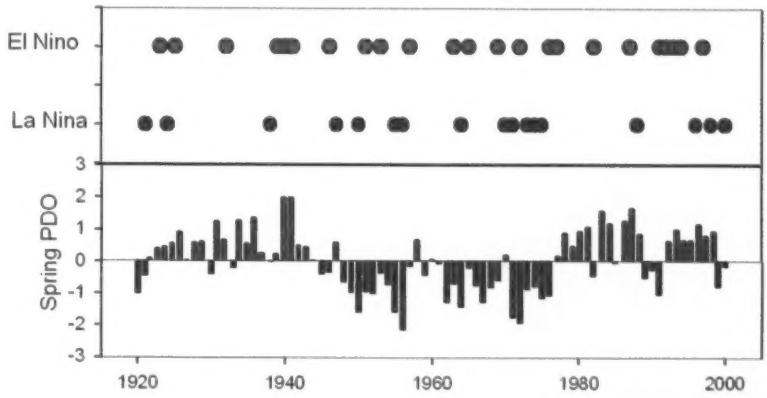
To complete the picture, further research will examine the influence of climate oscillations on cumulative drought indices, and on timing of snowmelt and vegetation leaf flush and APB using additional models and datasets.

For further information, please contact Steve Taylor (PFC) at Steve.Taylor@NRCan-RNCan.gc.ca 250-363-0758.



Time course of El Niño and La Niña winters, and spring PDO anomalies, 1920–2000.

Events

Value Creation in Canada's Forests—From Inventory to Operations: Canadian Wood Fibre Centre Electronic Lecture Series
Enhanced Forest Inventory—A National Approach.
George Bruemmer & Doug Pitt.
January 5

Managing for Value in Lodgepole Pine.
Roger Whitehead & Jim Stewart.
January 12

Operational Use of Remote Sensing Technologies in Ontario.
Murray Woods.
January 19

Tools and Methods to Maximize Value in Quebec's Forest.
Chhun-Huor Ung.
January 26

Mapping Fibre Attributes for Value in Newfoundland.
J. Luther, T. Moulton & B. English.
February 2

Correlations: Predicting Fibre Attributes in the Forest.
Art Groot.
February 9

FPInterface: A Planning Tool to Manage the Supply Chain.
Mathieu Blouin.
February 16

Tolerant Hardwoods: Higher Costs Can Mean More Value!
Jean Francois Gingras & Steve D'Eon
February 23

Information: http://www.cif-ifc.org/site/electure

Wood is Good 2011
February 24-25
Vancouver, BC
Information: http://www.expofor.ca/

Innovation in Forest Engineering—Adapting to Structural Change
April 5–7
Stellenbosch University,
White River, South Africa
Information: http://academic.sun.ac.za/forestry/FEC%202011/FEC%202011%20Home.htm

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New from the bookstore

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People

Departures

Dr. Al **Mitchell** started his career in 1974 at the Pacific Forestry Centre as a student and technician. Now, after 35 years of dedicated service at NRCan, Al retired on a high note after winning a Canadian Forest Service sector award for long-term research and promotion of science to the public. Over the years he has worked on long-term responses of Douglas-fir to fertilization, Pacific Yew and their adaptability in multiple environments, and amabilis fir and western hemlock at the Montane Alternative Silviculture Systems long-term research site.

In recent years, Al joined the new Canadian Wood Fibre Centre and worked as Pacific Region co-ordinator focusing on techniques for testing wood quality before. Affectionately nicknamed "Dr. Owl" by a group of five-year-olds recently touring the centre, he plans on sporting his trademark lab coat again during tours long after his retirement.

Art Shortreid passed away in March. Prior to joining Pacific Forestry Centre, Art worked at BC Forest Products and the Canadian Forest Service in their field office in Prince Albert, Saskatchewan. Sharing knowledge and experience with others was a big part of Art's career and included early forays into opening up the Japanese market to BC wood products. In 1992, Art received a major Public Service Achievement Award for Leadership, which recognized his role in securing the acceptance of GIS applications in natural resource management.

In the last phase of his career with CFS, Art advised many First Nations, community forests, and private land owners on forest management plans. He was also responsible for managing an afforestation programme related to emerging climate change and bio-energy issues.

A respected friend and colleague, Dr. Terry Shore, passed away unexpectedly in March. Terry received his PhD from UBC in Forest Entomology in 1982 and had a long and successful career as a researcher at Pacific Forestry Centre. He was recognized as a leading expert on the mountain pine beetle and earned world-wide recognition in the scientific community for his many contributions. Terry will be remembered for his kindness, unique sense of humor, love of golf, zest for life, and passion for his family.

Ritchie Shaw, a dear friend and colleague at PFC passed away in July. Ritchie began his career at NRCan as an electrician in 1991 and moved on to become Head of Building and Property Services for many years until his recent retirement. Ritchie's construction background and electrical knowledge was a very valuable asset to the organization. He truly enjoyed the work and the people at the Centre.

Arrivals

Welcome to David Dunn who is our new Head of the Chemical Services Laboratory. Prior to joining Pacific Forestry Centre, he spent 18 years as an Analytical Chemist with the BC Ministry of Forests and Range, Research Branch Analytical Chemistry Lab. His focus as Special Applications Chemist was to develop and document methods to satisfy client requests for unusual or non-routine analyses. Although David's main specialization is in liquid and gas chromatographic separations, he has extensive experience in all aspects of analyses relating to forest science research.

Aimin Guan was recently appointed as a Systems Developer within the National Forest Information System Project Office at the PFC. Aimin is no stranger to the Pacific Forestry Centre, having previously worked for Dr. David Goodenough in the Advanced Forestry Technology. Aimin has a BSc in computer science and is now pursing an MSc at UVic.

Prior to her appointment as Head of Publications at Pacific Forestry Centre, Shelley Church was the Publications Co-ordinator, Corporate Publications with FORREX for the past 7 years. While there, she managed the editorial process for a number of publications. Before joining FORREX, Shelley worked as an ecologist in forest ecology, forest entomology, and forest pathology research.

Accolades

National Public Service Week is a time to celebrate NRCan employees for special achievements that took them beyond the call of duty during the year. The Mountain Pine Beetle Program Delivery Team comprised of Bill Wilson, Nello Cataldo, David S. Harrison, Jacques Gagnon, Heather O'Leary, Maureen Scott, Sandra Allen, Diana Hassannia, and Murielle Warbis were presented with a Departmental Achievement Award. The Team was recognized for its outstanding achievements in the development and delivery of the $100-million program over the past four years. The Team consistently advanced NRCan's involvement in an environment that was often highly charged with conflicting assessments of proper priorities and funding allocations.

Answer to page 6

(A) water runway for float plane
(B) artificial insemination facility.

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